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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 16 (18): 955-959, 2013
ISSN 1028-8880 / DOI: 10.3923/pjbs.2013.955.959

Genetic Behaviour of Earliness Related Traits and Seed Yield in Chickpea (*Cicer arietinum* L.)

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Abstract: Genetic analysis of five quantitative traits related to earliness and seed yield in chickpea was carried out using eight segregating populations (F_2 generations) and their nine parents. Characters included in the study were days to flowering, flowering period, days to maturity, plant height and seed yield per plant. The results showed that no consistency in magnitude of genetic parameters was observed in any cross populations. However, the F_2 of $P_1 \times P_4$ exhibited high magnitude of heritability coupled with high genetic advance and GCV for flowering period, days to maturity and plant height and high heritability with moderate genetic advance and GCV for seed yield per plant. This indicated the involvement of additive gene action and potential for development of early maturing genotypes with enhanced seed yield. Correlation study revealed that days to flowering, flowering period and days to maturity recorded significant positive association among themselves. Though, their associations with seed yield per plant were weak in certain genetic backgrounds, otherwise almost non-significant. Thus, correlation studies revealed that selection for earliness will not directly increase productivity. The possibility of combining components of earliness with yield-promoting alleles was suggested.

Key words: F_2 populations, heritability, genetic advance, correlation

INTRODUCTION

Chickpea has good drought tolerance (Saxena *et al.*, 1993), making it well suited to the semi-arid regions worldwide. Indeed, chickpea is one of the few crops that can produce sustainable yield in relatively harsh environments (Kumar and Abbo, 2001). Earliness of crop maturity is important trait in many regions of the world. Earliness plays a central role in genotype adaptation to current and new environments and cropping systems and has a powerful effect on yield and yield stability (Kumar and Abbo, 2001). It may also protect the crop from various biotic and abiotic stresses such as diseases, heat, drought, etc. As a result, early maturity continues to be one of the major chickpea breeding objectives. The duration of crop maturity in chickpea is the end result of several phenological and morphological variables, which are interrelated and could be manipulated separately in the breeding process (Kumar *et al.*, 1999a). These include days to flowering, days to maturity, plant height, pod filling period, duration of flowering and others. Early maturity is a key agronomic trait for chickpea breeding, however, under circumstances where recording of the maturity date of genotypes is difficult due to forced maturation by environmental stress, some of these parameters may be used to discriminate between early and late genotypes. Generally, breeders have used days to flowering as a key indicator of maturity duration (Kumar and Abbo, 2001); however, additional gains may be possible by exploiting variation in other components. Moreover, effective alteration of final maturity duration would best be achieved by selecting for more than one component of crop duration. The effectiveness in manipulation of the components of crop duration in part depends upon understanding of the genetic bases of these traits.

Of particular importance to plant breeders is the proportion of the observed variability which is heritable. This determines the breeding methods to be used and the intensity of evaluation required to bring about rapid changes in the respective traits (Dudley and Moll, 1969). Information on predicted genetic gain from selection is also useful in predicting the progress that can be made through breeding/selection. Or *et al.* (1999) reported single major gene for time to flowering in chickpea. Several workers studied genetic variability and interrelationship for economically important traits in chickpea (Singh *et al.*, 1990; Kumar *et al.*, 1999a; Rao and

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Kumar, 2000; Sidramappa *et al*., 2008). The genetic information generated through different studies are influenced by the population used and inference to other chickpea parental lines and segregating populations may be invalid (Muehlbauer and Singh, 1987). Therefore, further study is needed to know genetic behaviour of earliness related traits and to predict their usefulness in breeding programmes. This is especially important under semi-arid region of western part of India, where environment regimes are so different compared to those experienced by the crop throughout its range of cultivation.

MATERIALS AND METHODS

The investigation regarding the genetic behaviour of traits related to earliness and grain yield per plant was carried out in the experimental area of the Junagadh Agricultural University College Farm. Nine genotypes namely, GJG 9905 (P_1), Vishal (P_2), ICC 4958 (P_3), JCP 27 (P_4), CSJ 103 (P_5), IPC 2000-52 (P_6), GJG 0106 (P_7), Pule G 96006 (P_8) and SAKI 9616 (P_9) with a range of divergence for earliness(maturity time) were selected (Table 1) from available germplasm, hereafter referred to as P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8 and P_9, respectively. Eight crosses in the combination of GJG 9905×Vishal (P_1×P_2), GJG 9905×ICC 4958(P_1×P_3), GJG 9905×JCP 27(P_1×P_4), GJG 9905×CSJ 103(P_1×P_5), JCP 27×CSJ 103(P_4×P_5), JCP 27×IPC 2000-52(P_4×P_6), GJG 0106×Pule G 96006(P_7×P_8) and GJG 0106×SAKI 9616(P_7×P_9) were attempted. The F_2 seeds harvested from F_1 plants were grown along with their nine parents under irrigated condition. A randomized block design with three replications was used for the execution of this experiment. Row to row spacing was kept 45 cm and seeds were hand dibbled at 10 cm distance in the rows of 4 m length. In a replication, each F_2 comprised five rows with 200 plants and each parent relegated to single row with 40 plants. Chemical fertilizers before sowing and irrigations after sowing to harvest of the crop were applied as per the practice in vogue of the region. Other agronomic practices and plant protection measures were also followed to grow the healthy crop. Observations were recorded from randomly selected 75 plants in each F_2 and five plants in each parent per replication for the traits like days to flowering, flowering period, days to maturity and seed yield per plant.

The data were subjected to standard analysis of variance to determine variation among the populations for the traits studied. Heritability in broad sense and genotypic coefficient of variation were computed by the method of Mahmud and Kramer (1951). Genetic advance to be expected from the selection of top 5% of plants was calculated for all the crosses as per the formula described by Allard (1960). Genetic advance is reported as percentage of mean and is the advance expected from one cycle of selection. Simple correlation coefficients between the traits were computed as per standard statistical procedure.

RESULTS AND DISCUSSION

The mean performance of days to flowering, flowering period, days to maturity plant height and seed yield per plant of nine parental lines are given in Table 1. The values for days to maturity ranged from 79 to 120 days. The early and late parents differed from each other by 41 days, indicating involvement of divergent parents for maturity time in the study. Similarly, it can be seen in this table that parents also showed fairly wide range of variation for days to flowering, flowering period and plant height, the characters likely to be associated with crop maturity duration. Late maturing parents have prolonged flowering period and tall plant stature. Seed yield per plant was recorded as low as 2.98 g (P_8) to as high as 7.98 g (P_4). In general, yield increase among the parents was observed to be associated with lateness.

Mean squares due to different sources for various traits are given in Table 2. Variance due to replication was non-significant for all traits, indicating that variability in F_2 plants was well distributed in all the replications. Mean squares of parents and crosses for the characters under consideration were highly significant. This signifies that

Table 1: Mean values for components of crop duration and seed yield per plant of the genotypes used in the study

Genotypes	Days to flowering	Flowering period	Days to maturity	Plant height (cm)	Grain yield/ plant (g)
GJG 9905 (P_1)	41	31	95	30	3.80
Vishal (P_2)	39	30	90	27	3.33
ICC 4958 (P_3)	45	35	103	33	4.17
JCP 27 (P_4)	51	42	115	30	7.98
CSJ 103 (P_5)	65	35	120	29	6.13
IPC 2000-12 (P_6)	48	38	108	25	4.64
GJG 0106 (P_7)	46	36	107	30	3.21
Pule G 96006 (P_8)	42	32	98	27	2.98
SAKI 9616 (P_9)	31	24	79	28	3.70

Table 2: Analysis of variance for days to flowering, flowering period, days to maturity and seed yield per plant in eight F_2 populations of chickpea

Source	d.f.	Days to flowering	Flowering period	Days to maturity	Plant height (cm)	Seed yield/ plant (g)
Replications	2	1.40	2.88	6.01	0.87	0.08
Genotypes	16	262.23**	72.76**	290.46**	17.21**	6.82**
Parents	8	227.91**	79.23**	466.79**	13.69**	7.09**
Crosses	7	329.87**	73.43**	113.45**	12.39**	5.70**
Parents vs. crosses	1	137.61**	98.09**	300.61**	163.57**	12.39**
Error	34	2.23	2.37	5.32	2.60	0.21

**Significant at 0.01 probability level

parents involved in crossing programme were divergent in nature and distinct variation among the F_2 populations studied. Significant variation due to parents *vs.* crosses indicated residual heterotic effects in the F_2 plants for components of earliness and seed yield per plant.

Genetic variability is a basic requirement for genetic improvement of a crop. Further, the knowledge of relative contributions of genetic components and environmental effects in controlling the variation for different quantitative traits is helpful for crop improvement (Kumar *et al.*, 1999b). This information allows breeders to employ improved strategies to develop more efficient selection methods and genetic populations (Nyquist and Baker, 1991). The present study worked out genotypic coefficient of variation, heritability and genetic advance as percentage of mean and also correlation coefficients for components of earliness and seed yield per plant in chickpea cross populations.

The range and mean values for earliness characters in F_2 population of eight crosses (Table 3) indicated that mean days to maturity varied from 93.07 to 112.27. The F_2 of $P_7 \times P_9$ was the earliest than any F_2s of remaining crosses. It was further observed that mean days to flowering of this population was lower than mid parent value and higher than that of its early parent (P_9) while mean value for days to maturity was almost in the middle of the parental values, indicating partial dominance for early flowering and additivity for maturity duration. Partial dominance for early flowering and maturity was observed to be involved in the F_2 of $P_1 \times P_5$. The $P_1 \times P_4$ and $P_4 \times P_6$ expressed higher F_2 mean for days to flowering than their corresponding late flowering parent, indicating overdominance and transgressive segregation for late flowering. The F_2 mean for flowering period was higher than longer flowering period parent in the $P_1 \times P_2$, $P_1 \times P_3$ and $P_1 \times P_5$ and shorter than short flowering period parent in the $P_1 \times P_4$, $P_4 \times P_5$ and $P_4 \times P_6$. This suggested the phenomenon of transgressive segregation for longer flowering period in former three crosses and shorter flowering period in later three crosses. Similarly, transgressive segregation was also observed for seed yield per plant in the $P_1 \times P_5$, $P_7 \times P_8$ and $P_7 \times P_9$. Overdominance was observed to be involved in the expression of seed yield per plant.

The estimates of Genotypic Coefficient of Variation (GCV) ranged from 5.21 to 37.51% for days to flowering, 1.77 to 40.37 for flowering period, 6.15 to 25.28% for days to maturity, 41.94 to 69.16% for plant height and 4.30 to 26.04% for seed yield per plant (Table 4). This indicates that as compared to other characters, plant height

Table 3: Mean and range for some earliness parameters and seed yield per plant in eight F_2 populations of chickpea

	Days to flowering		Flowering period		Days to maturity		Plant height (cm)		Seed yield/plant (g)	
Population#	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
$P_1 \times P_2$	39.20	38.2-39.8	36.13	35.4-37.2	99.20	98.2-99.8	30.33	29.2-30.9	3.38	3.3-3.5
$P_1 \times P_3$	42.81	41.2-43.8	36.07	35.2-36.6	102.47	100.2-103.8	31.88	31.2-32.6	3.07	3.0-3.1
$P_1 \times P_4$	57.07	56.2-57.6	26.40	25.4-27.2	107.14	105.2-108.8	31.54	30.6-32.6	5.69	5.6-5.7
$P_1 \times P_5$	44.67	43.8-45.2	36.60	35.8-37.6	104.67	103.8-105.2	33.54	32.6-34.8	7.17	7.0-7.4
$P_4 \times P_5$	63.07	62.2-63.8	25.40	23.2-27.4	112.27	110.2-113.4	27.40	26.2-28.8	6.35	5.8-6.9
$P_4 \times P_6$	58.60	57.2-59.4	27.80	25.8-29.4	110.40	109.2-111.4	33.11	31.4-34.8	4.92	4.8-5.0
$P_7 \times P_8$	44.88	44.0-45.4	35.74	34.2-37.8	104.87	103.0-106.2	32.48	31.2-33.8	4.95	4.9-5.0
$P_7 \times P_9$	33.07	31.8-33.8	35.40	34.2-36.6	93.07	91.8-93.8	29.64	28.6-30.8	5.17	5.1-5.2

#Parent codes as per Table 1

Table 4: Genetic parameters for days to flowering, flowering period, days to maturity and seed yield per plant in eight F_2 populations of chickpea#

Character/genetic parameter	$P_1 \times P_2$	$P_1 \times P_3$	$P_1 \times P_4$	$P_1 \times P_5$	$P_4 \times P_5$	$P_4 \times P_6$	$P_7 \times P_8$	$P_7 \times P_9$
Days to flowering								
GCV	5.21	12.61	9.11	9.04	9.52	9.03	37.51	11.51
Heritability (%)	36.91	66.66	60.85	55.33	56.61	56.83	93.23	74.36
GA mean (%)	4.77	11.55	5.86	8.27	8.72	8.26	34.34	10.54
Flowering period								
GCV	1.77	11.23	21.91	15.38	19.59	40.33	34.64	16.62
Heritability (%)	19.84	61.34	64.64	78.84	56.01	82.82	89.00	66.45
GA mean (%)	1.62	10.28	20.06	14.08	17.94	36.93	31.71	15.22
Days to maturity								
GCV	8.31	15.94	24.04	16.48	23.59	6.15	11.66	25.28
Heritability (%)	46.94	60.92	77.21	70.01	72.21	53.83	81.56	89.02
GA mean (%)	7.61	14.59	22.01	15.09	21.60	5.63	10.67	23.14
Plant height (cm)								
GCV	57.76	41.74	52.86	42.68	60.84	43.13	65.52	69.16
Heritability (%)	81.98	78.46	77.78	77.26	83.37	72.93	89.38	91.97
GA mean (%)	52.88	38.22	48.39	39.08	55.70	39.49	59.98	63.32
Seed yield/plant (g)								
GCV	26.04	14.80	17.30	12.92	4.94	14.27	4.30	8.96
Heritability (%)	85.60	85.72	94.26	79.09	58.88	70.30	49.87	62.01
GA mean (%)	19.65	13.55	16.14	11.83	4.53	13.07	3.93	8.20

#Parent codes as per Table 1

expressed large amount of variability in all the populations. Though the variability for other characters was not so consistent but observed to be high (>20% GCV) in certain genetic backgrounds. According to Tefera *et al.* (2003), accumulation of heritability information for traits from different genetic populations is useful to ascertain its true magnitude. Since chickpea is a highly inbreeding species, additive genetic variation is needed by breeders aiming to improve quantitative traits (Muehlbauer and Singh, 1987).

Among the characters studied, seed yield per plant showed the highest heritability of 94.26% in the cross $P_1 \times P_4$ (Table 4). Further, high magnitude of heritability(>70%) together with high genetic advance as percentage of mean (>20%) was observed for days to flowering in $P_7 \times P_8$, flowering period in $P_1 \times P_4$, $P_4 \times P_6$ and $P_7 \times P_8$ and days to maturity in $P_1 \times P_4$, $P_4 \times P_5$ and $P_7 \times P_9$. On the other hand, plant height displayed high heritability coupled with high genetic advance in all the crosses. Thus, it is evident that magnitude of genetic parameters observed to vary with characters and cross populations. However, high magnitude of heritability coupled with high genetic advance and GCV for flowering period, days to maturity and plant height and high heritability with moderate genetic advance and GCV for seed yield per plant of F_2 of the $P_1 \times P_4$ indicated the involvement of additive gene action and potential possibilities for development of early maturing genotypes with enhanced seed yield.

The value of correlation coefficient (Table 5) indicated that days to flowering, flowering period and days to maturity were strongly and positively correlated among each other, but the associations of these traits with plant height were non-significant in almost all the crosses. This suggests that plant height should not be a component of earliness. Seed yield per plant was not correlated with days to flowering, flowering period and days to maturity in the populations studied, except $P_4 \times P_6$, in which positive weak associations were obtained. Such weak but negative association for seed yield per plant with flowering period was observed in $P_7 \times P_9$.

Bonfil and Pinthus (1995) suggested that because of its indeterminate growth habit, the duration of the chickpea flowering period is a major yield determinant. Synchronized flowering also increases uniform pod maturity and post-flowering vegetative growth. The duration of the reproductive period is restricted between the commencement of flowering and the early-summer high air temperatures that terminate seed set. Therefore, selection for condensed flowering period genotypes in which plant types tended to be determinate and the reproductive sink uses the majority of the post-flowering assimilate supply could improve earliness of crop maturity as well as seed yield in the short growing environment of the region. However, it is believed that days to maturity in chickpea are untenable and generally breeders have used days to flowering as an indicator of crop duration. In practice, early flowering genotypes do not necessarily mature early and some late flowering genotypes have a short reproductive period and mature simultaneously with earlier flowering ones (Summerfield and Roberts, 1988). Since early flowering leads to early onset of reproductive growth, combined selection for days to flowering and flowering period would enable more gain in improving earliness of crop maturity. Since significant positive association was observed between these traits, simultaneous improvement of days to flowering, flowering period and days to maturity should be feasible.

In the present study of eight F_2 populations, no correlation was found for days to flowering, flowering period and days to maturity with seed yield per plant. Nevertheless, the data (Table 5) suggest that one or more components of earliness may be associated in certain genetic backgrounds with low or high seed yield per plant, though the associations were weak. Several causes may account for the lack of a simple relationship between

Table 5: Simple correlation coefficients for days to flowering, flowering period, days to maturity and seed yield per plant in eight F_2 populations of chickpea[#]

Character combinations	$P_1 \times P_2$	$P_1 \times P_3$	$P_1 \times P_4$	$P_1 \times P_5$	$P_4 \times P_5$	$P_4 \times P_6$	$P_7 \times P_8$	$P_7 \times P_9$
Days to flowering								
Flowering period	0.53**	0.85**	0.74**	0.78**	0.77**	0.60**	0.78**	0.79**
Days to maturity	0.81**	0.95**	0.85**	0.89**	0.86**	0.86**	0.94**	0.94**
Plant height (cm)	-0.07	-0.03	0.14	-0.11	-0.01	-0.02	0.08	0.08
seed yield/plant (g)	-0.07	-0.12	0.09	0.01	-0.01	0.17*	0.07	0.07
Flowering period								
Days to maturity	0.75**	0.85**	0.91**	0.80**	0.93**	0.86**	0.84**	0.89**
Plant height (cm)	0.10	-0.02	0.06	-0.12	0.03	0.09	0.20**	0.01
Seed yield/plant (g)	0.03	-0.09	-0.03	-0.06	0.11	0.20**	0.09	-0.14*
Days to maturity								
Plant height (cm)	0.08	-0.02	0.09	-0.07	0.06	0.01	0.12	0.10
Seed yield/plant (g)	0.00	-0.11	0.03	-0.02	0.08	0.18**	0.06	-0.12
Plant height (cm)								
Seed yield/plant (g)	0.40**	0.36**	0.21**	0.22**	-0.03	0.35**	0.13	0.31**

[#]Parent codes as per Table 1, **Significant at 0.01 probability level them in this work. It is clear that selection for earliness will not directly increase productivity. The possibility of combining components of earliness with yield-promoting alleles was demonstrated in desi chickpea (Siddique and Khan, 1996). Chickpea crosses may need to involve gene introgression from across desi and kabuli types and from wild relatives. In this way, breeders could better tailor earliness of crop maturity.

ACKNOWLEDGMENT

The financial assistance from Junagadh Agricultural University for the research work is highly acknowledged.

REFERENCES

Allard, R.W., 1960. Principles of Plant Breeding. 1st Edn., John Wiley and Sons Inc., New York.

Bonfil, D.J. and M.J. Pinthus, 1995. Response of chickpea to nitrogen and a comparison of the factors affecting chickpea seed yield with those affecting wheat grain yield. Exp. Agric., 31: 39-47.

Dudley, J.W. and R.H. Moll, 1969. Interpretation and use of estimates of heritability and genetic variances in plant breeding. Crop Sci., 9: 257-262.

Kumar, S., H.A. Van Rheenen and O. Singh, 1999a. Genetic analysis of different components of crop duration in chickpea. J. Genet. Breed., 53: 189-200.

Kumar, V., C.S. Kar, P.C. Sharma and V. Kumar, 1999b. Variability, correlation and path coefficient analysis in chickpea (*Cicer arietinum* L.). Environ. Ecol., 17: 936-939.

Kumar, J. and S. Abbo, 2001. Genetics of flowering time in chickpea and its bearing on productivity in semiarid environments. Adv. Agron., 72: 107-138.

Mahmud, I. and H.H. Kramer, 1951. Segregation for yield, height and maturity following a soybean cross. Agron. J., 43: 605-609.

Muehlbauer, F.J. and K.B. Singh, 1987. Genetics of Chickpea. In: The Chickpea, Saxena, M.C. and K.B. Singh (Eds.). CAB. International, Wallingford, Oxon, OX10 8DE, UK., pp: 99-125.

Nyquist, W.E. and R.J. Baker, 1991. Estimation of heritability and prediction of selection response in plant populations. Criti. Rev. Plant Sci., 10: 235-322.

Or, E., R. Hovav and S. Abbo, 1999. A major gene for flowering time in chickpea. Crop Sci., 39: 315-322.

Rao, S.K. and K.S. Kumar, 2000. Analysis of yield factors in short duration chickpeas (*Cicer arietinum*). Agric. Sci. Digest, 20: 66-67.

Saxena, N.P., C. Johansen, M.C. Saxena and S.N. Slim, 1993. Selection for Drought and Salinity Tolerance in Cool-Season Food Legumes. In: Breeding for Stress Tolerance in Cool-Season Food Legumes, Singh, K.B. and M.C. Saxena (Eds.). A Wiley-Sayce Co-Publication, Chichester, UK., pp: 245-270.

Siddique, K.H.M. and T.N. Khan, 1996. Early-flowering and high-yielding chickpea lines from ICRISAT ready for release in Western Australia. Int. Chickpea Pigeonpea Newslett., 3: 22-24.

Sidramappa, S., A. Patil, P.M. Salimath and S.T. Kajjidoni, 2008. Direct and indirect effects of phenological traits on productivity in recombinant inbred lines population of chickpea. Karnataka J. Agric. Sci., 21: 491-493.

Singh, K.B., G. Bejiga and R.S. Malhotra, 1990. Associations of some characters with seed yield in chickpea collection. Euphytica, 49: 83-88.

Summerfield, R.J. and E.H. Roberts, 1988. Photothermal Regulation of Flowering in Pea, Lentil, Faba Bean and Chickpea. In: World Crops-Cool Season Food Legumes, Summerfield, R.J. (Ed.). Kluwer Academic Publishers, Dordecht, The Netherlands, pp: 911-922.

Tefera, H., K. Assefa, F. Hundera, T. Kefyalew and T. Teferra, 2003. Heritability and genetic advance in recombinant inbred lines of tef (*Eragrostis tef*). Euphytica, 131: 91-96.